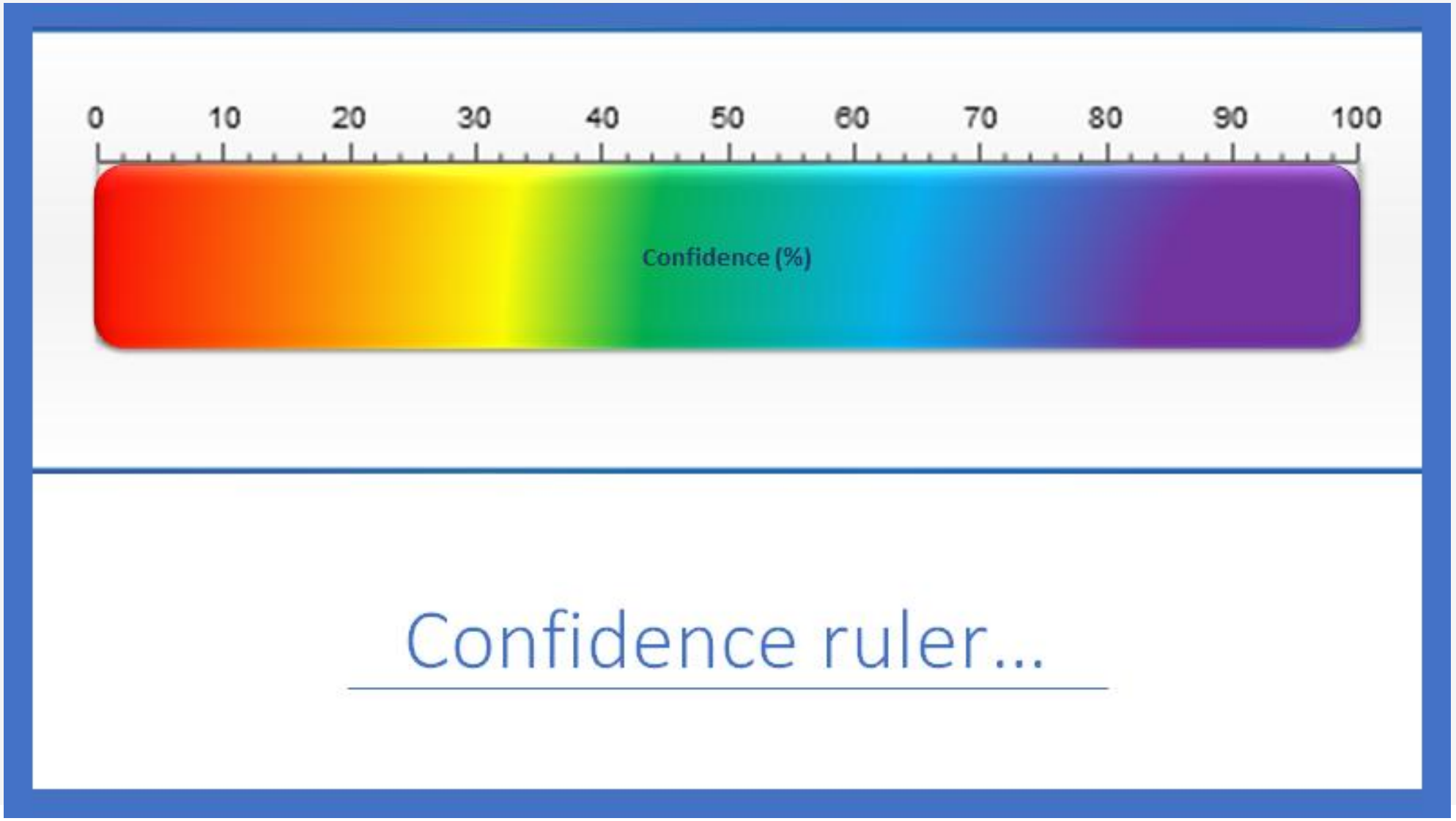
What makes science?

You will:

- challenge your own understanding of what Mathematics is;
- Explain the distinctive nature of mathematics knowledge
- consider how an understanding of what Maths is fits with the school curriculum to develop numerate students that can draw informed conclusions and reflect on findings to ask new questions;

Relevant CCF statements S3 subject knowledge
Learn that
A school's curriculum enables it to set out its vision for the knowledge, skills and values that its pupils will learn, encompassing the national curriculum within a coherent wider vision for successful learning.
Explicitly teaching pupils the knowledge and skills they need to succeed within particular subject areas is beneficial

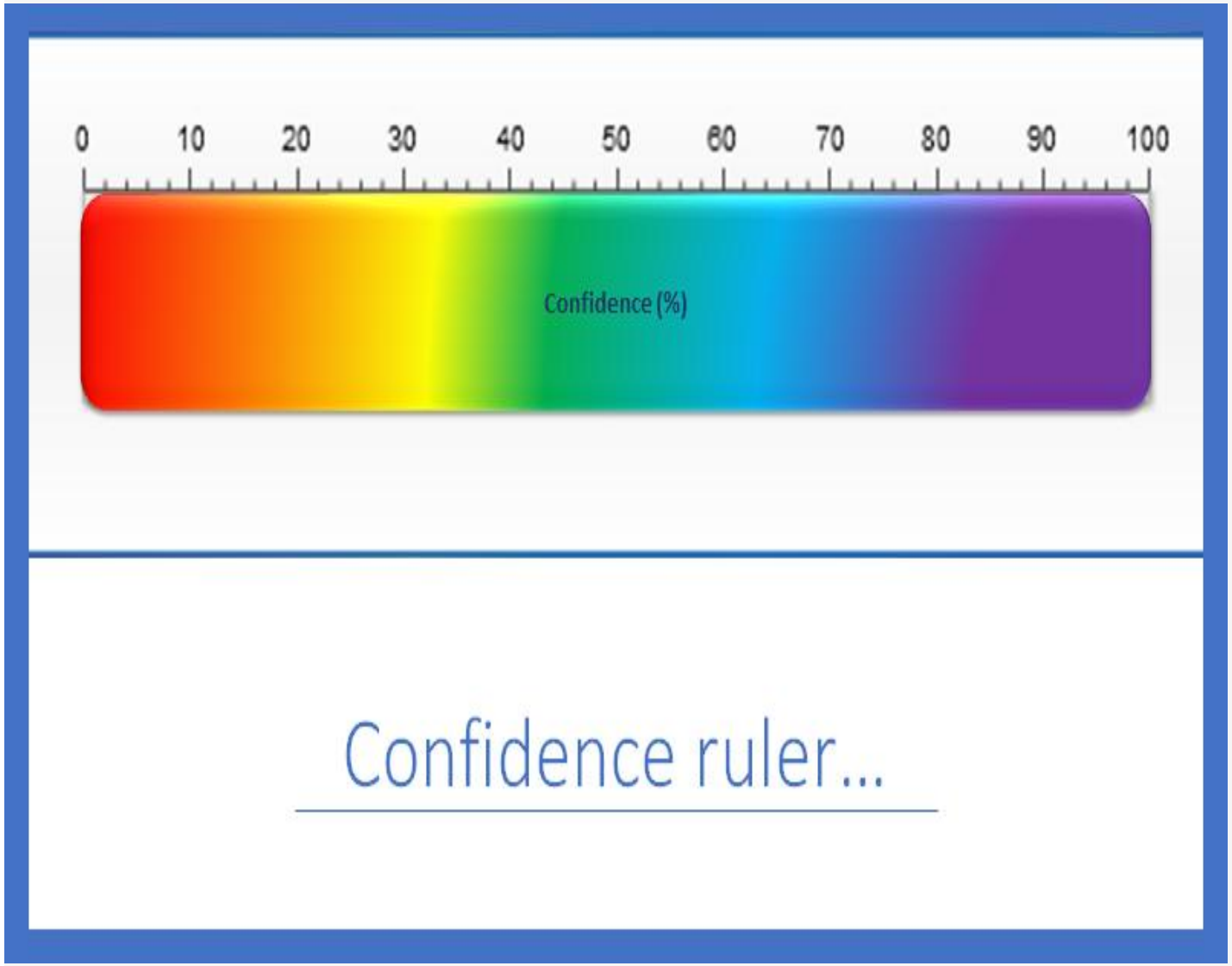
Confidence ruler



Confidence

What are in the tins?
How confident are you?

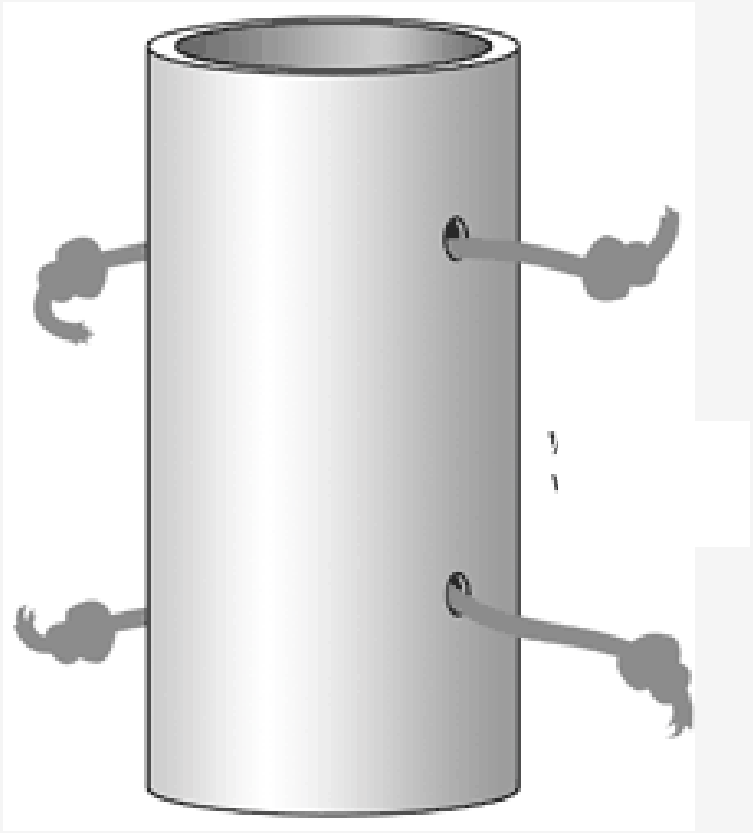
Share your thoughts on the confidence ruler



What was in the tins?

- Paper clips
- Tissue Paper
- Air
- Rice
- Marbles

What can science tell us?



Pull on the different ends of the string.

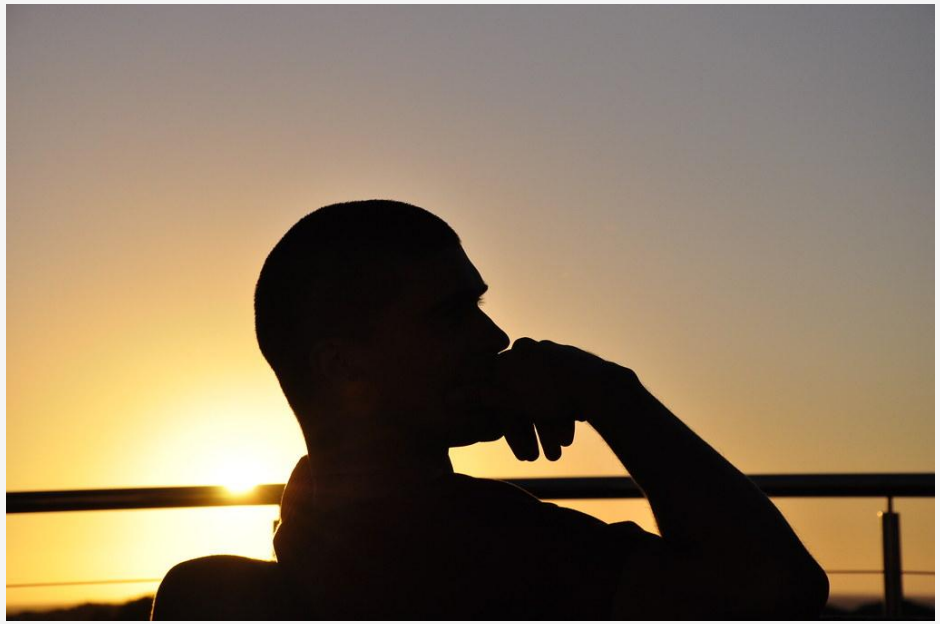
Draw how you think the string is interconnected in the mystery tube.

Present your drawings to your table partner and to the wider group. Justify your thinking.

Underneath your original drawing redraw how you now think the pieces of string are interconnected.

- https://undsci.berkeley.edu/lessons/mystery_tubes.html
- https://www.ase.org.uk/resources/school-science-review/issue-367/mystery-tubes-teaching-pupils-about-hypothetical-modelling

What is your reflection on the last activity?



What did you notice in that last activity?

Was there a common theme in the drawings?

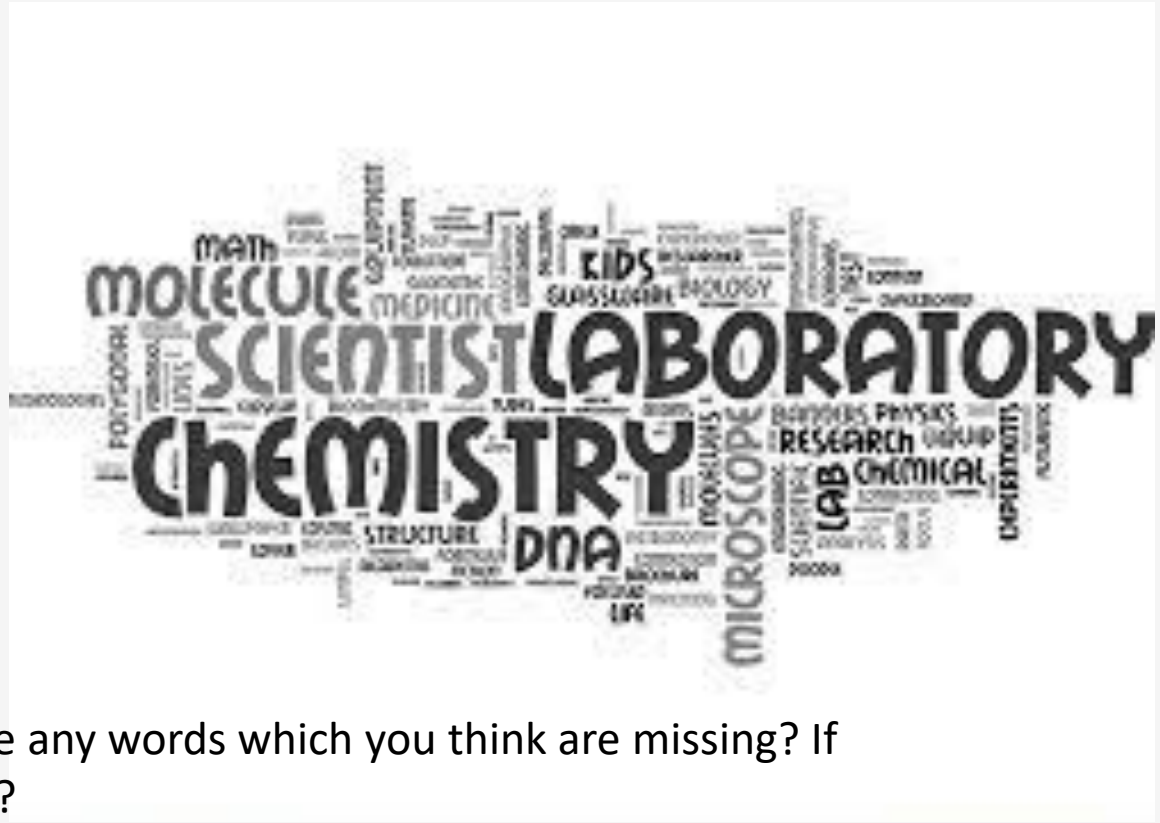
Did you adapt your original drawing? Why?

What does this tell you about science?

What are the distinctive features of science.

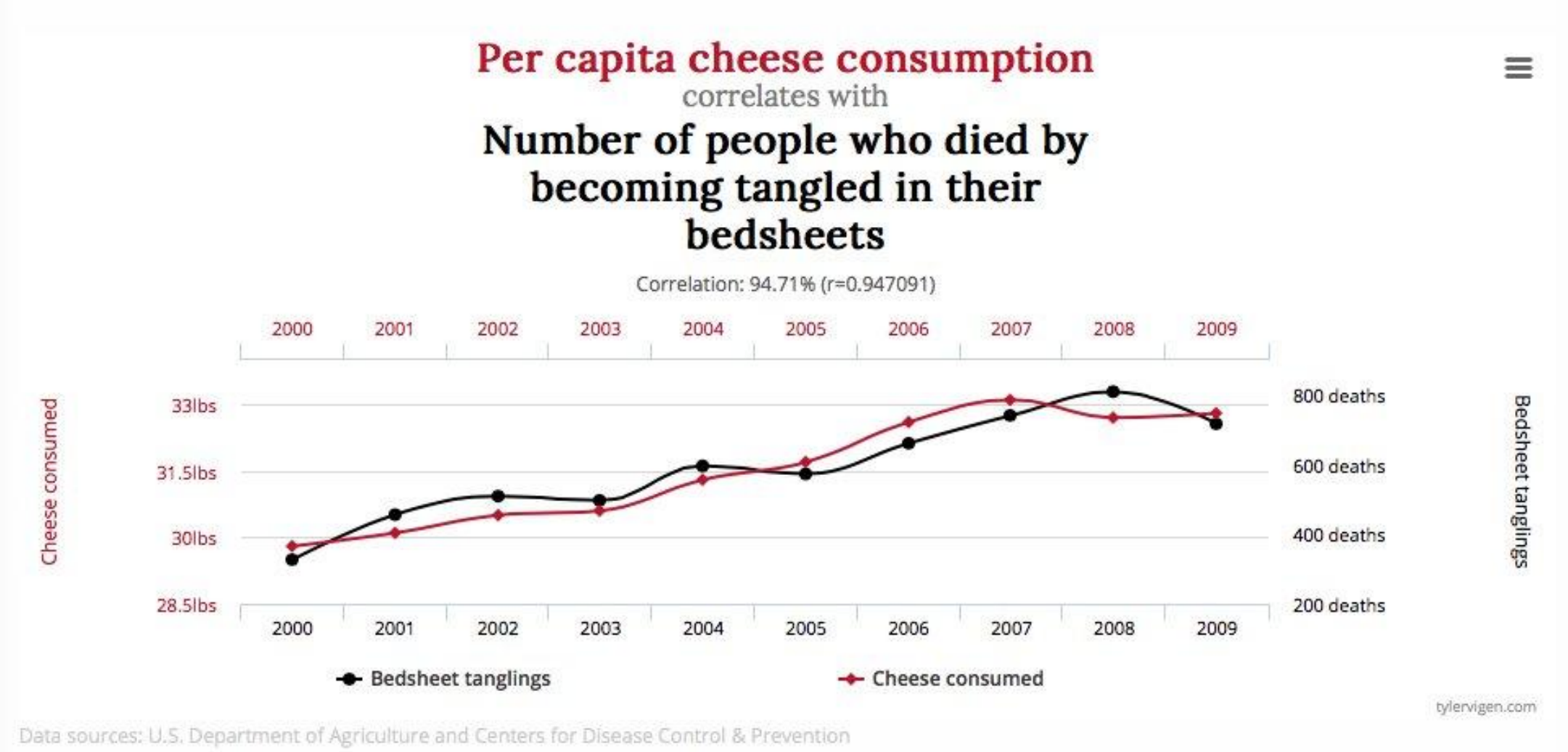
- Write the words to describe the distinctiveness of science in the vevox app

Word walls to describe science.

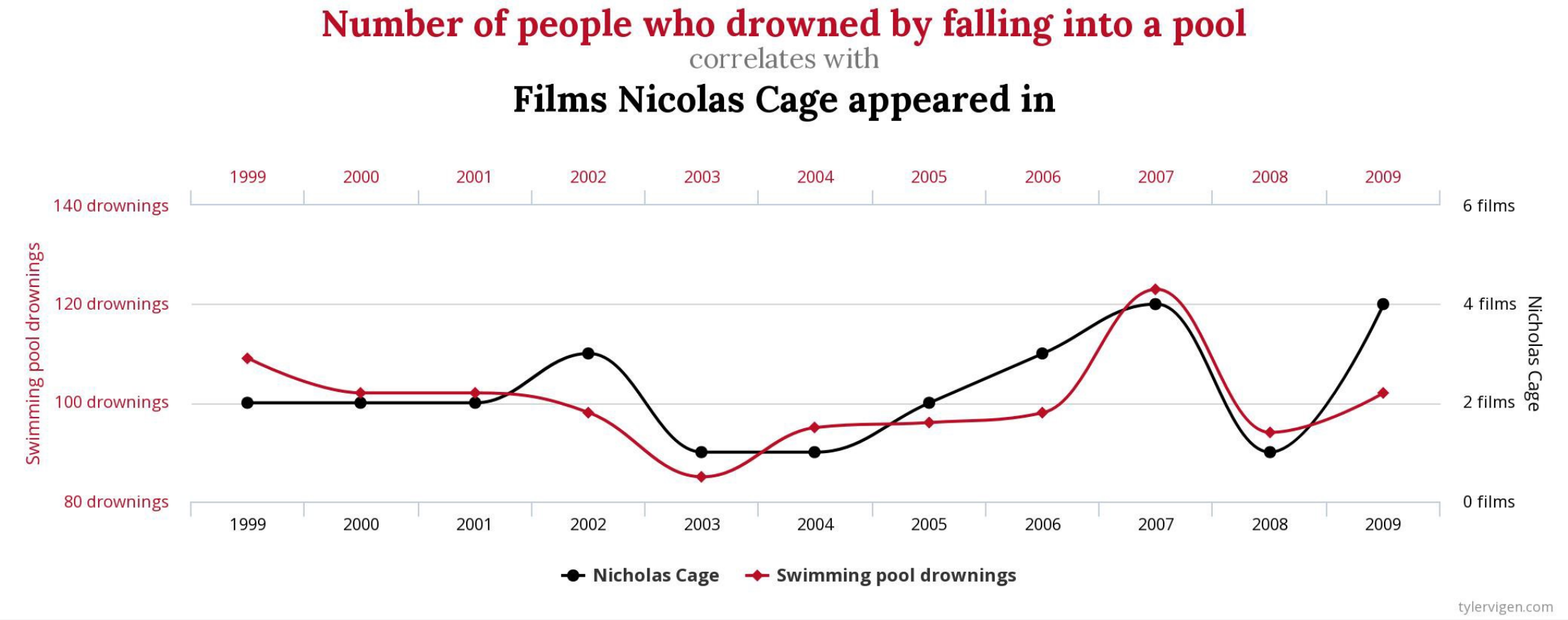


Do you agree with either of the word walls more? Are there any words which you think are missing? If somebody asked you what is science? What would you say?

What can data show us?



What can data show us?



Introducing curriculum intent

Purpose of study

A high-quality science education provides the foundations for understanding the world through the specific disciplines of biology, chemistry and physics. Science has changed our lives and is vital to the world's future prosperity, and all pupils should be taught essential aspects of the knowledge, methods, processes and uses of science. Through building up a body of key foundational knowledge and concepts, pupils should be encouraged to recognise the power of rational explanation and develop a sense of excitement and curiosity about natural phenomena. They should be encouraged to understand how science can be used to explain what is occurring, predict how things will behave, and analyse causes.

Aims

The national curriculum for science aims to ensure that all pupils:

- develop **scientific knowledge and conceptual understanding** through the specific disciplines of biology, chemistry and physics
- develop understanding of the **nature, processes and methods of science** through different types of science enquiries that help them to answer scientific questions about the world around them
- are equipped with the scientific knowledge required to understand the **uses and implications** of science, today and for the future.

DfE (2013); Millar (2014)

A nature of science

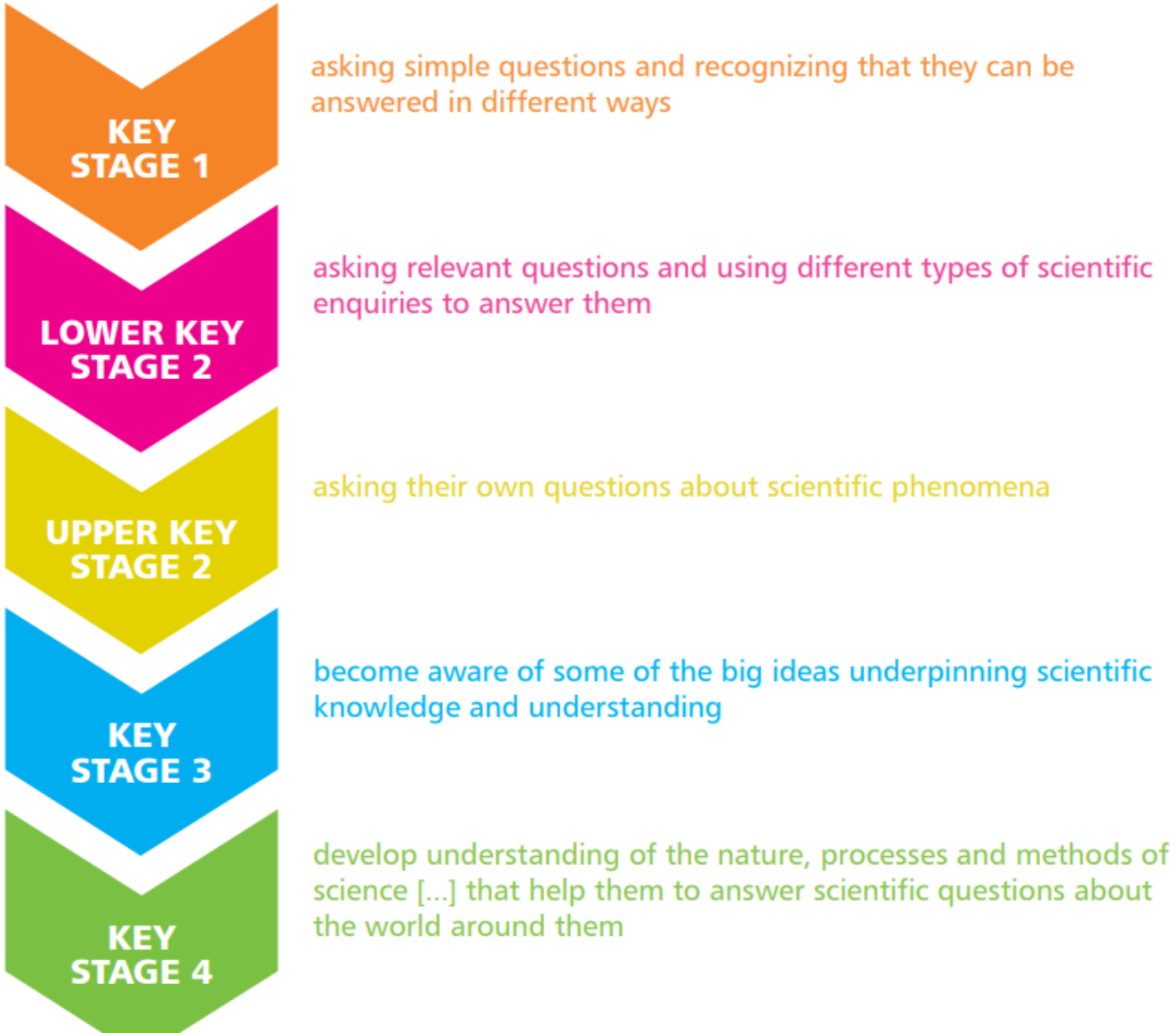
- Understanding nature of science is a prerequisite of developing scientific literacy. Scientific literacy is the understanding of the role science can play in solving real world problems.

- According to Lederman, Abd-el-Khalick, Bell and Schwartz (2002) there are five components of science that combine to make science distinctive. One in isolation is not distinctive, but also seen in other subjects.
- Development of knowledge is based on empirical evidence taken from experiments.
- Scientific knowledge is tentative
- Development of scientific knowledge is creative.
- Development of knowledge is theory laden.
- Development of knowledge is linked to inquiry.

An exemplar KS3 curriuculum

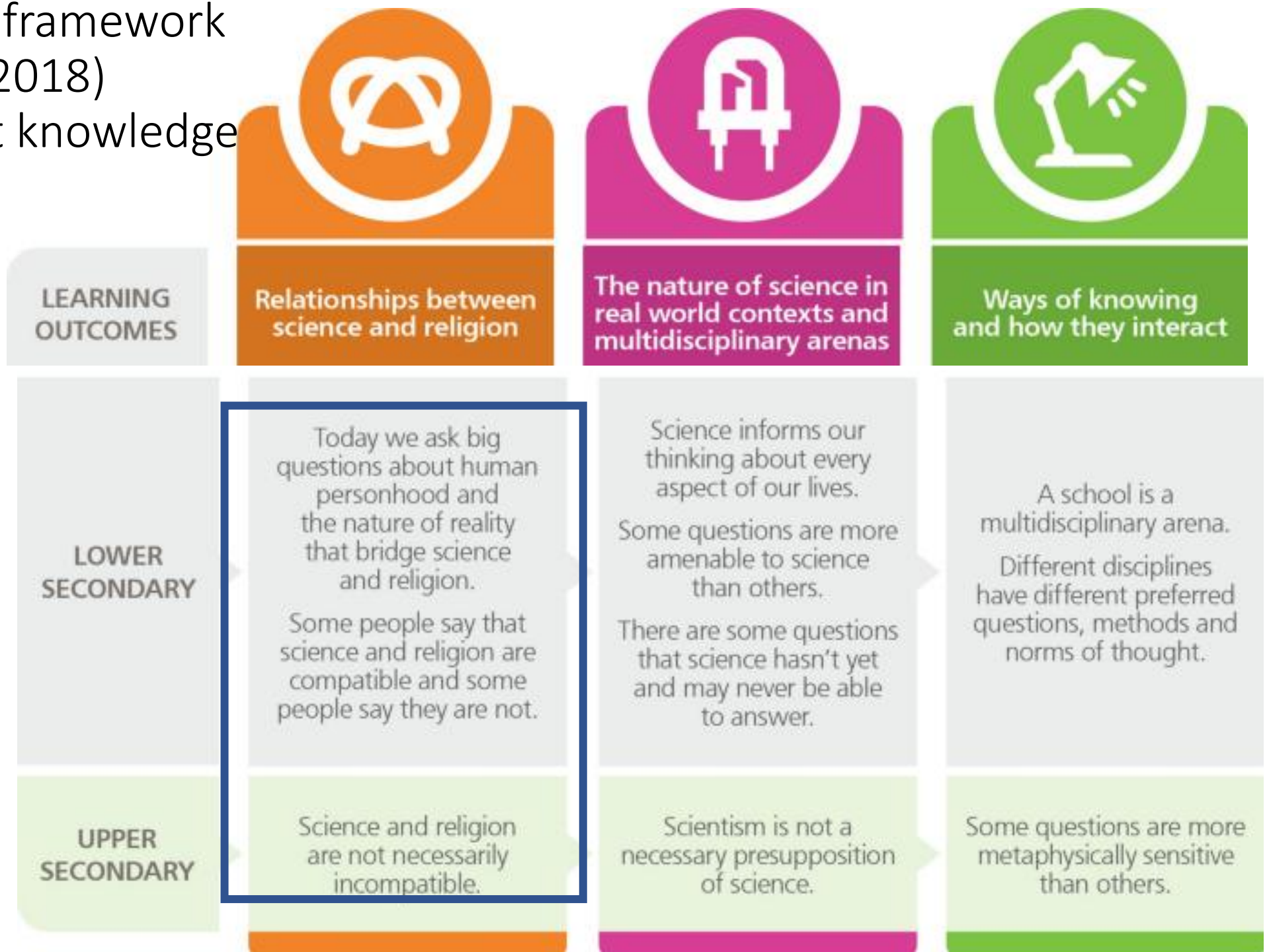
- https://filestore.aqa.org.uk/resources/science/specifications/AQA-SCIENCE-KS3-SYLLABUS.PDF

What we expect our students to be able to do



LASAR (2021) https://www.epistemicinsight.com/wp-content/uploads/2021/01/PW-secondary-cpd-guidebook-vOCT20.pdf

Epistemic insight framework
Billingsley et. al (2018)
Knowledge about knowledge



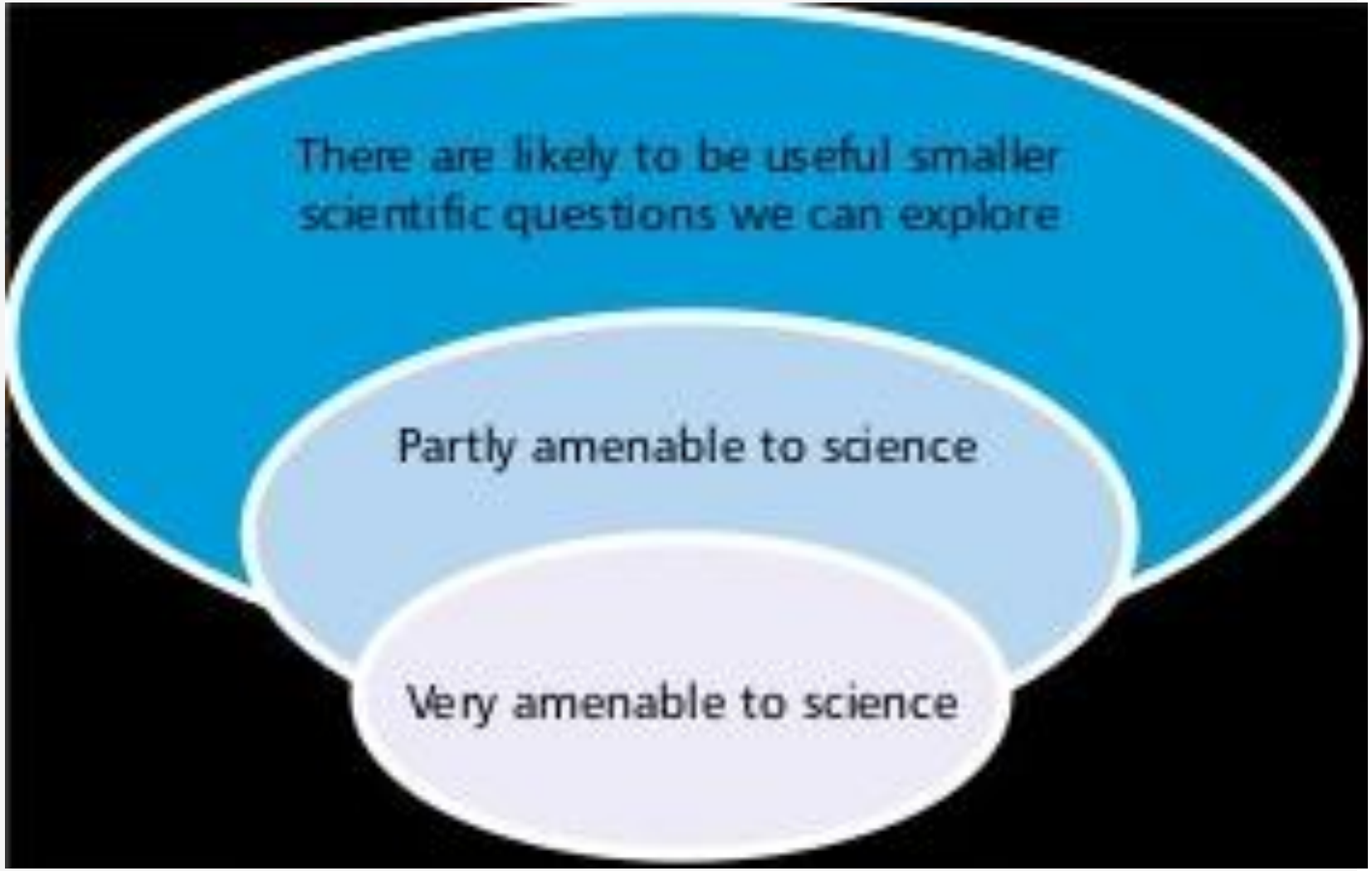
Exemplar resources The bubble tool

There are some questions that can be answered by science alone.

Some questions require knowledge from other disciplines.

On the next slide are a list of questions, where would you place them on the bubble tool?

What do you notice about how the questions are constructed?



Moving beyond the curriculum content

Questions

Questions which investigate the nature of the world around us

Methods

- Hypothesis
- Observation
- Data collection
- Analysis
- Proof/evidence

Ways of thinking

- Objectivity
- Replicability
- Consensus

Epistemic Insight

What makes a good question?

1. What makes a question a good question for science to answer?
2. What makes a question a good question for geography to answer?
3. What makes a question a good question for history to answer?

Can science answer these questions?

1. How do you know that plants photosynthesise?
2. How do I know you have a toothache?
3. How do you know that I am in love?
4. How do you know the sun will rise tomorrow?
5. 6. How is the SARS-CoV-2 virus transmitted?
7. Should we ban cattle farming to reduce climate change?
8. Should Freedom day have happened on 19th July?
9. How do we know global warming is causing climate change?

- Science Alone?
- Informed by science?
- Better answered by other disciplines?

Exemplar question

- What is a footprint?

Extension:

How will you support those you teach recognise different disciplines can answer the same question in different ways?

What is science?

- Come back to the question we posed earlier.
- If someone asked you what is science, what would you say?
- Review and refine the answer you wrote earlier and share your answer with the group.

Where does this fit within your University lectures?

Your teaching approach will likely depend on your view on the purpose of science education.

For example do you run a practical to discover theory, or prove something you have already taught the children?

The following sessions build on this further

Science specific sessions
Purposeful practicals

Working scientifically

Questioning
Collaborative sessions between science and RE
Collaborative sessions between science and history
Collaborative sessions between science and PE
Collaborative session between science and Maths
Potentially microteaching
Professional studies sessions on epistemic insight.

A final thought

I think it's much more interesting to live not knowing than to have answers which might be wrong. I have approximate answers and possible beliefs and different degrees of uncertainty about different things, but I am not absolutely sure of anything and there are many things I don't know anything about, such as whether it means anything to ask why we're here. I don't have to know an answer. I don't feel frightened not knowing things, by being lost in a mysterious universe without any purpose, which is the way it really is as far as I can tell.

(Richard Feynman, The pleasure of finding things out 1981)

References

Billingsley, B., Nasaji, M., Fraser, S. and Lawson, F. (2018) A framework for teaching epistemic insight in schools, Research in science education 48, pp. 1115-1131 DOI 10.1007/s11165-018-9788-6

DfE(2013) Science programme of study-key stage 3 National curriculum in England, London: Crown court. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/335174/SECONDARY_national_curriculum_-_Science_220714.pdf Accessed on 19th July 2021.

DfE (2014) Science programme of study-key stage 4 National curriculum in England, . London: Crown court. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/381380/Science_KS4_PoS_7_November_2014.pdf Accessed on 19th July 2021.

Lederman, N., Abd-el-Khalick, F., Bell, R.L., & Schwartz, R.S. (2002). Views of Nature of Science Questionnaire: Towards valid and meaningful assessment of learners' conceptions of the nature of science. *Journal of Research in Science Teaching,* **39**, pp.497–521.

Millar, R. (2014) Designing a science curriculum fit for purpose, *school science review,*95(352),pp 15-20.